The A. & M. College of Texas

Department of
OCEANOGRAPHY AND METEOROLOGY

STRUCTURE OF THE CONTINENTAL SHELF, NORTHEASTERN GULF OF MEXICO
(Preliminary Report)

John W. Antoine and James L. Harding

Office of Naval Research — Project NR083-036
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by

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A & M Project 286-1

REFERENCE 63-13T

May 1963

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INTRODUCTION

The data reported herein is a portion of a paper presented at the Annual Meeting of the American Association of Petroleum Geologists in Houston, Texas on March 25, 1963. The paper was entitled: The Structure of Portions of the Northern Continental Shelf, Gulf of Mexico, as Determined by Seismic Refraction Measurements.

Due to numerous requests from professional geologists and geophysicists actively working in the Gulf Coast area for copies of the above paper and its illustrations, it was decided that, although the data presented was in essence a mere progress report, this technical report would facilitate the widest possible distribution at the earliest date.

The original paper as given at the Houston meetings was of two parts, one concerning the structure off the Texas coast, and the other that off the coast of the Florida Panhandle. The former is adequately covered in a recent publication: Antoine and Ewing (1963). This report represents that data presented concerning the Florida area. The results are summarized in Table 1. The reader is reminded of the preliminary nature of this material. Subsequent work will prove or disprove much of the discussion.

The writers wish to acknowledge the aid of the Florida Geological Survey, especially Mr. Clarence Babcock, in obtaining information regarding the control wells on the mainland.

METHODS

The standard seismic refraction methods that were used are described in detail by Officer et al. (1959). The majority of the charges used on these profiles were shot on a one-minute schedule with the shooting ship proceeding at 1/2 speed, approximately 4 knots. This resulted in a shot point every 600-700 feet out to an approximate distance of six miles from the receiving ship. After six miles, larger charges were used and the distance between shots was increased.

STRUCTURE OF THE CONTINENTAL SHELF

Figure 1 shows the location of the reversed profiles obtained by Texas A. and M. personnel to date in the northeast Gulf of Mexico. The Continental Shelf, immediately south and east of Panama City, Florida, is the zone of heaviest coverage.

Correlative interpretation between numerous wells drilled in close proximity to the shoreline and the postulated depths to the bottom and top of the Cretaceous is shown in Figures 2 and 3. The Upper Cretaceous

TABLE 1. Receiving Positions, Seismic Velocities, and Layer Thicknesses, Hidalgo 1961 and 1962. Assumed velocities are indicated by asterisks. Seismic velocities are given in both km/sec and ft/sec. Layer thicknesses are given in both kilometers and feet.

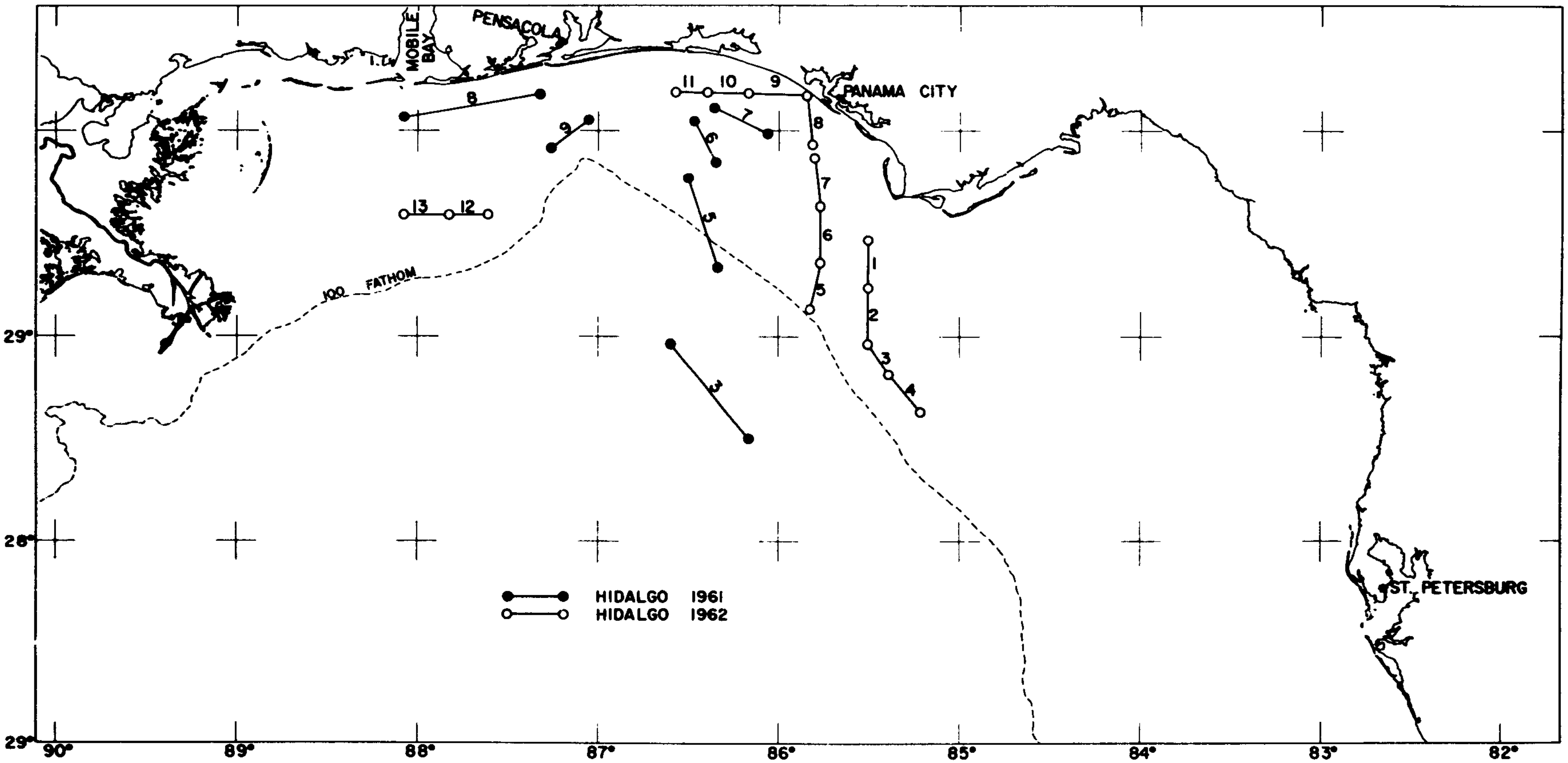
Pro-file	Position	Velocity km/sec ft/sec								Water Depth	>1.7 km/sec	Thicknesses km ft						
		A	B	C	D	E	F	G	H			A	B	C	D	E	F	G
								HIDALGO 1961										
3A	28°57'	1.8*	3.1	4.2	5.3	5.7				.40	.21	.43	.89	1.26	3.95			
	86°34'	5900	10200	13800	17400	18700				1320	690	1410	2920	4130	12950			
3B	28°28'									.37	.15	.44	.75	.97	4.12			
	86°10'									1200	490	1440	2460	3180	13500			
5A	29°20'	1.8*	2.1	2.5	3.2	4.3	5.2*			.23	.13	.29	.15	.43	1.16	1.06		
	86°18'	5900	6900	8200	10500	14100	17050			755	930	955	490	1410	3810	3480		
5B	29°43'									.15	.09	.19	.32	.62	1.06	2.40		
	86°33'									490	295	625	1050	2035	3480	7890		
6A	30°02'	1.7	2.4	2.7	3.6	5.0				.07	.04	.18	.44	.56	2.88			
	86°28'	5575	7875	8850	11800	16400				230	130	590	1445	1840	9450			
6B	29°52'									.08	.07	.13	.47	.55	3.21			
	86°21'									260	230	425	1540	1800	10500			
7A	30°07'	1.9	2.3	2.6	3.3	3.7*	4.1	4.7	5.9	.04	.00	.21	.27	.73	.71	.55	1.40	2.63
	86°22'	6250	7550	8550	10800	12130	13450	15400	19350	130	.00	690	885	2390	2320	1800	4600	8640
7B	29°58'									.03	.01	.22	.24	.75	1.22	.79	.98	.83
	86°04'									110	33	720	790	2460	4000	2590	3210	2720
8A	30°12'	1.9	2.5	3.0	4.3	5.0	5.5*			.03	.01	.31	.47	1.48	1.74	1.85		
	87°17'	6250	8200	9850	14100	16400	18000			100	33	1030	1540	4850	5710	6070		
8B	29°57'									.03	.11	.61	.58	.79	1.04	2.79		
	88°05'									85	360	2000	1900	2590	3410	9150		
9A	29°54'	1.8	2.7	3.5	4.2					.03	.07	.49	.86	1.35				
	87°15'	5900	8850	11500	13800					100	230	1610	2820	4430				
9B	30°03'									.05	.06	.31	1.10	.94				
	87°01'									180	195	1030	3610	3080				

TABLE 1. Continued

Pro- file	Position	Velocity km/sec ft/sec A	B	C	D	E	F	G	H	Water Depth	>1.7 km/sec	Thicknesses km ft A	B	C	D	E	F	G
								HIDALGO 1962										
1A	29°28' 85°31'	Records unuseable																
1B	29°14' 85°30'	Records unuseable																
2A	29°14' 85°30'	1.8* 5900	2.4 7875	3.4 11150	4.0* 13100	4.9 16100				.06 180	.00 0	.26 855	.46 1510	.95 3115	.99 3250			
2B	28°58' 85°31'									.15 490	.00 0	.20 655	.55 1800	.99 3250	1.28 4200			
3A	28°58' 85°31'	1.8 5900	2.1 6900	3.4 11150	3.9 12800	5.3 17400				.15 490	.00 0	.17 560	.56 1835	.83 2720	1.43 4700			
3B	28°49' 85°23'									.11 360	.04 130	.14 460	.50 1640	.49 1610	1.83 6000			
4A	28°49' 85°23'	2.0 6580	2.6* 8530	3.4 11150	4.1 13450	5.3 17400				.11 360	.09 295	.26 855	.47 1540	.74 2420	1.53 5020			
4B	28°38' 85°12'									.14 470	.06 195	.43 1410	.23 755	.96 3150	1.18 3870			
5A	29°08' 85°49'	2.0 6560	2.3* 7550	3.4 11150	4.1 13450	5.4 17700				.16 500	.10 330	.38 1245	.37 1210	1.13 3710	1.40 4600			
5B	29°22.5' 85°46.5'									.05 180	.06 195	.33 1080	.57 1870	.87 2850	1.81 5950			
6A	29°22.5' 85°46.5'	1.8 5900	2.4 7875	3.4 11150	4.1 13450	4.9 16100				.05 170	.00 0	.33 1080	.61 2000	.96 3150	2.09 6850			
6B	29°38' 85°47'									.03 110	.02 65	.24 790	.57 1870	.80 2620	2.64 8650			
7A	29°38' 85°47'	2.0 6560	2.5 8200	3.2 10500	3.8 12450	5.3 17400				.03 110	.01 30	.29 950	.59 1935	.54 1770	2.63 8650			
7B	29°52' 85°48									.03 110	.01 30	.26 855	.76 2490	.68 2230	2.24 7350			

TABLE 1. Continued

Pro- file	Position	Velocity km/sec ft/sec A	 B	 C	 D	 E	 F	 G	 H	Water Depth	>1.7 km/sec	Thicknesses km ft A	 B	 C	 D	 E	 F	 G
8A	30°10.5' 85°51'	2.2 7200	2.6 8550	3.2 10500	3.6 11800	5.1 16700	6.3* 20700			.01 30	.10 330	.29 950	.65 2130	.84 2755	1.78 5850	2.75 9025		
8B	29°56' 85°48'									.03 110	.08 260	.35 1150	.56 1835	.89 2920	2.03 6650	1.43 4700		
9A	30°10.5' 85°51'	1.8 5900	2.5 8200	3.4 11150	4.8 15750	6.0* 19700				.01 30	.02 65	.30 985	.68 2230	2.46 8075	1.99 6540			
9B	30°11' 86°10'									.03 95	.01 30	.37 1210	.81 2660	2.28 7500	2.34 7700			
10A	30°11' 86°10'	1.7 5575	2.6 8550	3.5 11500	4.3 14100	5.1 16700				.03 95	.02 65	.27 885	.91 2980	1.59 5220	1.48 4850			
10B	30°11' 86°24'									.03 95	.02 65	.28 920	1.04 3410	1.46 4790	1.23 4030			
11A	30°11' 86°24'	1.7 5575	1.9 6250	2.5 8200	3.8 12450	5.3 17400				.03 95	.00 0	.29 950	.46 1510	.99 3240	1.28 4200			
11B	30°11' 86°34'									.03 95	.00 0	.33 1080	.46 1510	1.07 3510	1.30 42[illegible]			
12A	29°36' 87°37'	1.8 5900	2.6 8550	3.7 12130	5.6 18400					.04 130	.06 195	.73 2400	1.03 3380	1.43 4690				
12B	29°36' 87°50'									.04 130	.10 330	.67 2200	1.20 3940	1.28 4280				
13A	29°36' 87°50'	2.0 6560	2.6 8550	3.3 10800	4.3 14100	5.8 19000				.04 130	.04 130	.20 655	.68 2230	1.90 6240	1.70 5580			
13B	29°36' 88°05'									.04 130	.01 30	.32 1050	.60 1970	1.75 5750	2.57 8440			



MOBILE BAY
PENSACOLA
PANAMA CITY
ST. PETERSBURG
100 FATHOM
HIDALGO 1961
HIDALGO 1962
29°
28°
90°
89°
88°
87°
86°
85°
84°
83°
82°

FIGURE I

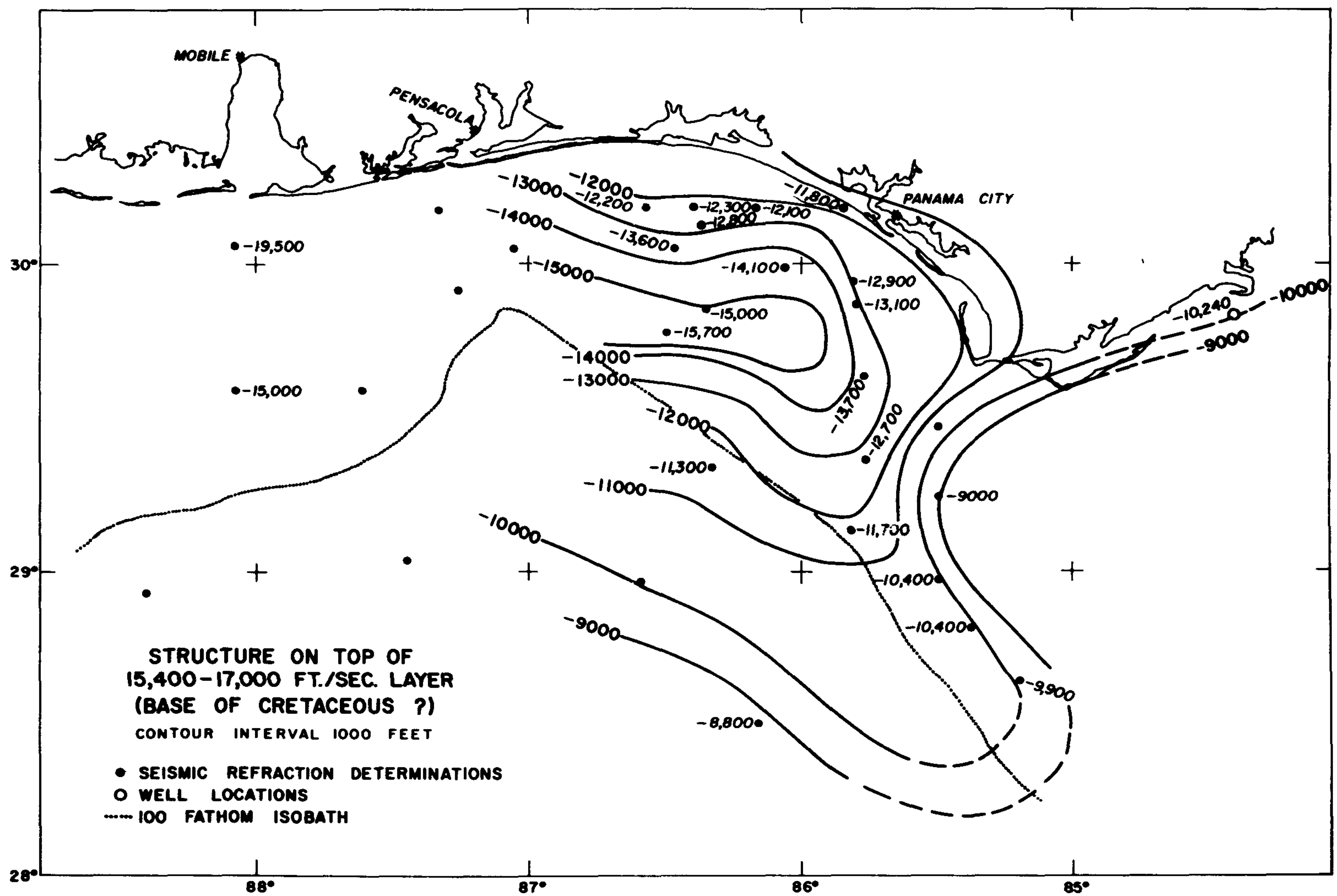
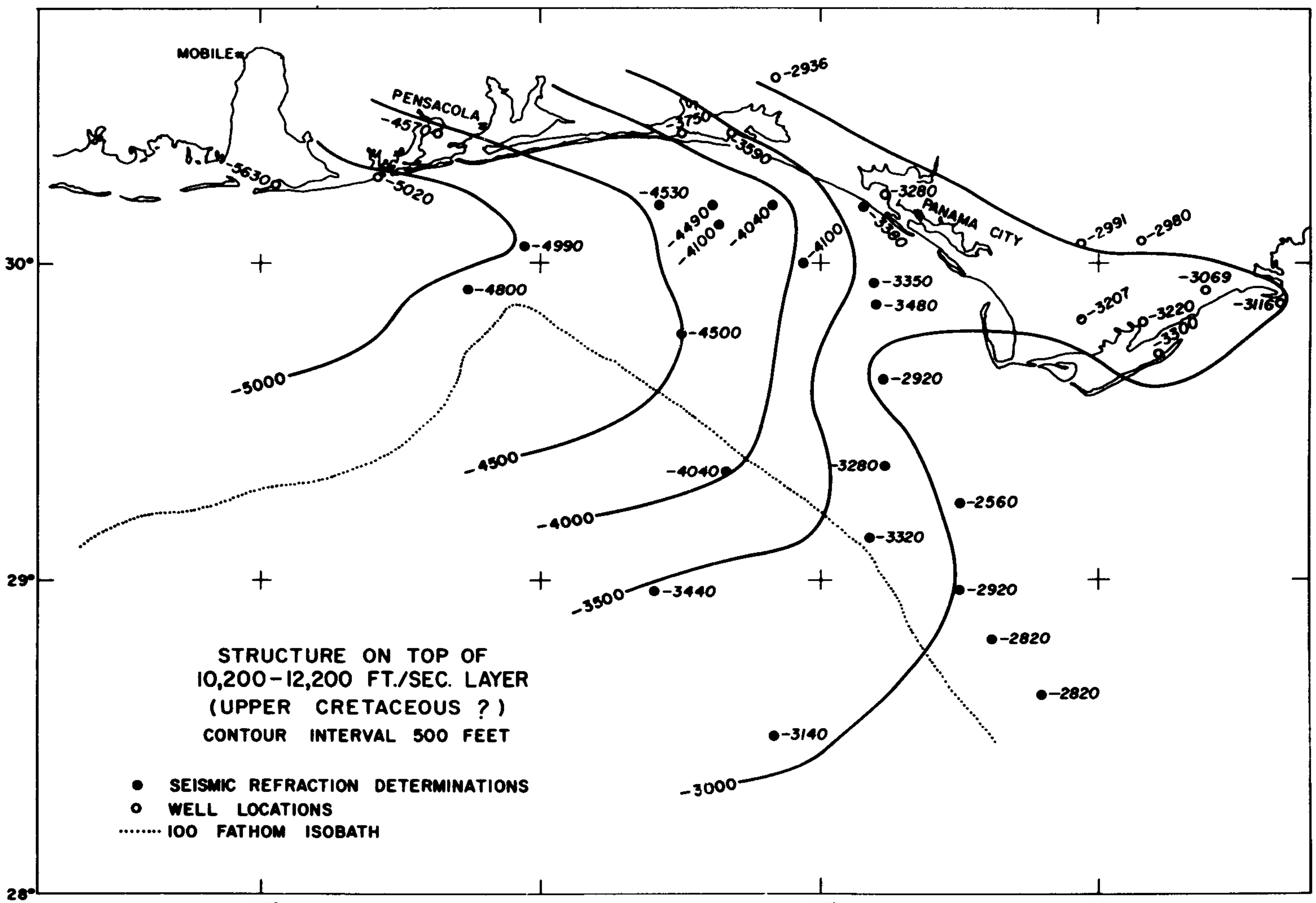

MOBILE
PENSACOLA
PANAMA CITY
30°
29°
28°
88°
87°
86°
85°
-19,500
-15,000
-13000
-12000
-12,200
-12,300
-12,100
-11,800
-12,800
-14000
-13,600
-15000
-14,100
-12,900
-13,100
-15,000
-15,700
-14000
-13000
-13,700
-12,700
-12000
-11,300
-11000
-10000
-9000
-11,700
-9000
-10,400
-10,400
-9,900
-8,800
-10,240
-10000
-9000
STRUCTURE ON TOP OF
15,400-17,000 FT./SEC. LAYER
(BASE OF CRETACEOUS ?)
CONTOUR INTERVAL 1000 FEET
● SEISMIC REFRACTION DETERMINATIONS
O WELL LOCATIONS
100 FATHOM ISOBATH

FIGURE 2



MOBILE
PENSACOLA
PANAMA CITY
-5630
-4570
-5020
-4990
-4800
-4530
-4490
-4100
-4040
-4100
-3750
-3590
-3380
-3280
-2936
-2991
-2980
-3069
-3207
-3220
-3300
-3160
-3350
-3480
-2920
-4500
-4040
-3280
-2560
-3320
-2920
-2820
-2820
-3440
-3140
-5000
-4500
-4000
-3500
-3000
30°
29°
28°
88°
87°
86°
85°
STRUCTURE ON TOP OF
10,200-12,200 FT./SEC. LAYER
(UPPER CRETACEOUS ?)
CONTOUR INTERVAL 500 FEET
SEISMIC REFRACTION DETERMINATIONS
WELL LOCATIONS
100 FATHOM ISOBATH

FIGURE 3

interface is correlated with the 10,800 ft/sec layer (value is an average figure). This interpretation appears essentially valid, as close agreement exists with many mainland well-control points. The best correlations are with the Hawkins-Coffee Well (south of Choctawhatchee Bay), and the Magnolia State Bank Well #4, near Panama City, Florida.

The relationship between the 16,400 ft/sec layer (average) and the pre-Cretaceous surface is not too well established and needs further clarification. Only one well drilled in the nearshore area penetrated the entire Cretaceous on St. Georges Island, and it was necessary to extrapolate the dip of this interface from further inland where a number of wells have penetrated the entire Cretaceous section.

Figure 2 illustrates the structure on top of the average 16,400 ft/sec layer. As stated above, it is thought to approximate the pre-Cretaceous surface. Certainly, the illustration is, at best, a first approximation. Two outstanding features are noticeable: (1) the trough south of the coastline and (2) the rise of the corresponding interface to the east and to the south of the trough. The trough is depicted as paralleling the coast, roughly 40-50 miles offshore, and in its deepest portion contains in excess of 15,000 feet of sedimentary fill. The axis of this trough is roughly aligned to that of the Gulf Coast Geosyncline more accurately defined in the Texas and Louisiana area.

There exists a gross similarity between this trough and the Gulf Coast Geosyncline south of Texas (Antoine and Ewing, 1963) as in both cases well-defined rock units rise structurally toward the south. In the case of the Florida area, however, very little is known about the extent of this feature, except that Profile 3 (Fig. 1) indicates that it is rather broad.

It is of interest to note that the 16,400 ft/sec layer is found at a depth of 19,500 feet south of Mobile Bay. As this point is approximately aligned with the axis of the trough-like feature, it would seem to indicate a thickening of sediments to the west; certainly becoming more analogous to the areas off the Texas and Louisiana coasts.

Figure 3 illustrates the structure on top of the 10,800 ft/sec interface, which is interpreted as approximating the top of the Upper Cretaceous. The well-control onshore was excellent for this horizon, and very little interpolation was necessary. As will be noted, the trough-like feature so well illustrated in Figure 2 loses much of its definition, exhibiting a poorly defined axis. However, the basic trend is still in the same approximate direction. Also, the same regional thickening of the sediments to the west can be noted.

The rising of the beds to the east is somewhat more noticeable in the Upper Cretaceous than in the Lower. However, it still remains somewhat problematical as its off-shore configuration is primarily based on one seismic determination and relationships to other points in the vicinity. There is also some suggestion of a separate embayment to the northeast,

possibly related to the Southwest Georgia Embayment, which will be discussed below.

Figure 4 is a cross-section drawn from Choctawhatchee Bay due south to beyond the shelf-slope break. One will note that although the trough is well defined in the 16,400 ft/sec layer, it is not discernible in the 10,800 ft/sec layer or in the overlying layers.

ONSHORE FEATURES

Due to the preliminary nature of this work, correlations with known regional structures were attempted, rather than explanations of localized features. Principal among these regional features are the following components:

A. Ocala Uplift
B. Marianna-Decatur Uplift (Chattahoochee Arch)
C. Southwest Georgia Basin
D. Suwannee Strait

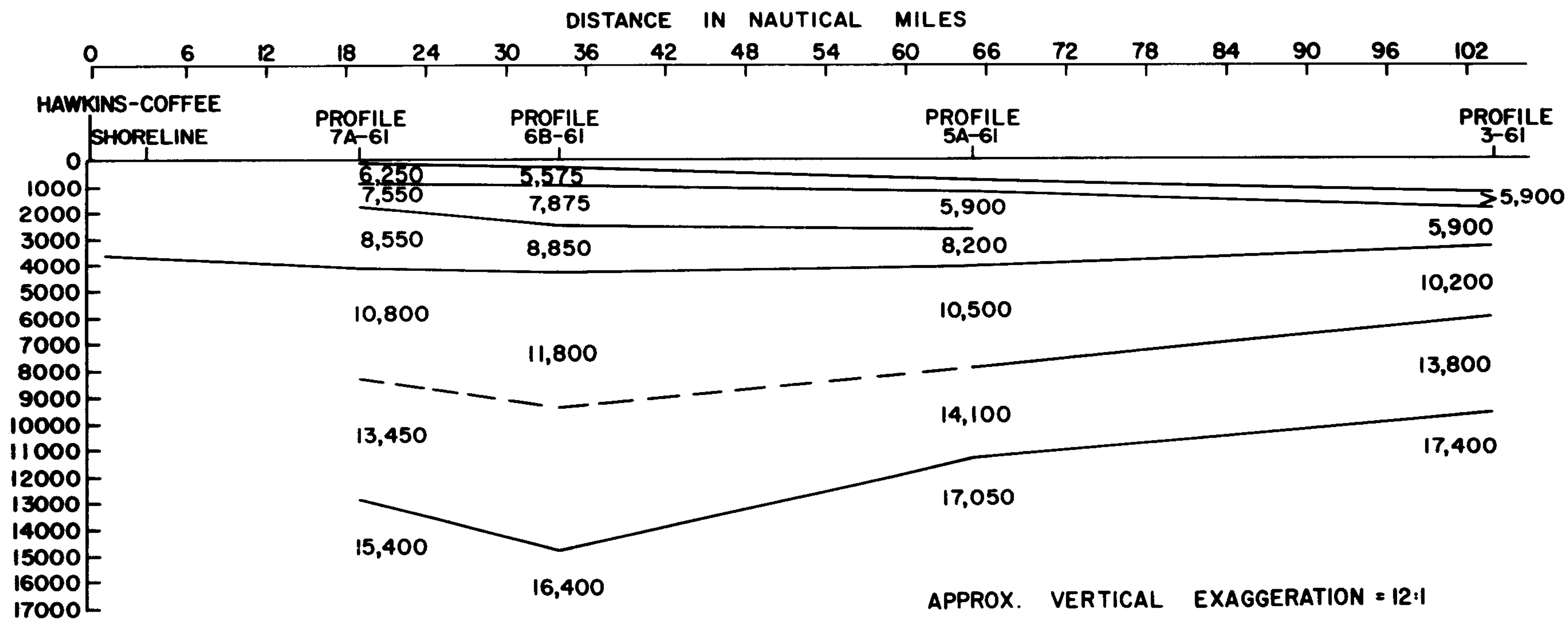
The locations of these and other features are presented in Figure 5.

Ocala Uplift. The Ocala Uplift has variously been termed the Central Georgia Uplift, the Peninsular Arch, and the Ocala Arch. Murray (1961) believes these to be only time-and-space variations of the overall positiveness of the entire Florida Peninsula. However, Vernon (1951) is of the opinion that the Peninsular Arch represents the Late Paleozoic and Mesozoic structural high, while the Ocala Uplift was the locus of upwarping in the Tertiary.

Marianna-Decatur Uplift (Chattahoochee Arch). This is a gentle structural upwarping, which has its maximum area of expression in the tristate contact (Ala.-Fla.-Ga.) and which has an axis roughly paralleling the Chattahoochee River (Murray, 1961). The extent of the influence of this structure on the adjacent coastal and off-shore areas is unknown. However, according to most workers it forms the western and northwestern limits of the Southwest Georgia Basin.

Southwest Georgia Basin. Murray (1961, p. 103) locates this feature by the change in strike of strata of the Gulf Coastal Plain from about east-west to approximately north-south in southwestern Georgia and northern Florida. The axis of the embayment is generally northeast-southwest. The sedimentary fill in the basin itself is chiefly late Mesozoic.

Suwannee Strait. The Suwannee Strait is an elongate feature located between the Ocala Uplift and the Southwest Georgia Basin. The feature was noted by the absence of the Late Cretaceous (Navarro and Taylor) beds which are present on either side of the "strait." Baum (1953) and Jordan (1954) have suggested that it represents an erosional feature. Hull (1962) presents an opposite view, arguing for an area of non-deposition,



DISTANCE IN NAUTICAL MILES
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
HAWKINS-COFFEE
SHORELINE
PROFILE 7A-61
PROFILE 6B-61
PROFILE 5A-61
PROFILE 3-61
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
6,250
7,550
8,550
10,800
13,450
15,400
5,575
7,875
8,850
11,800
16,400
5,900
8,200
10,500
14,100
17,050
≥5,900
5,900
10,200
13,800
17,400
APPROX. VERTICAL EXAGGERATION = 12:1

FIGURE 4

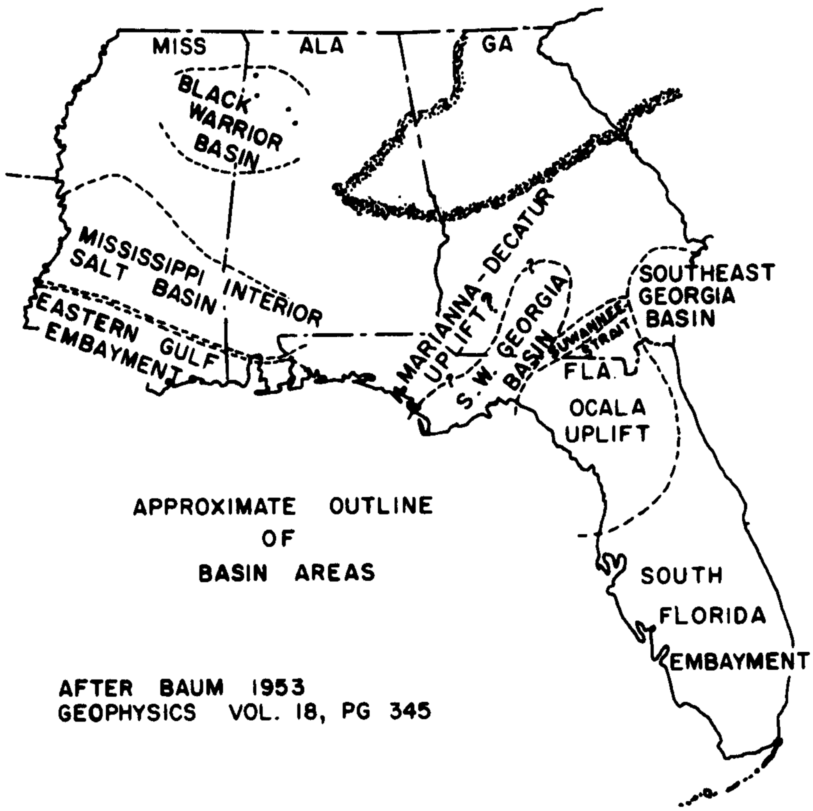

MISS
ALA
GA
BLACK WARRIOR BASIN
MISSISSIPPI INTERIOR SALT BASIN
EASTERN GULF EMBAYMENT
MARIANNA-DECATUR UPLIFT?
S.W. GEORGIA BASIN
SUWANNEE STRAIT
SOUTHEAST GEORGIA BASIN
FLA.
OCALA UPLIFT
SOUTH FLORIDA EMBAYMENT
APPROXIMATE OUTLINE
OF
BASIN AREAS
AFTER BAUM 1953
GEOPHYSICS VOL. 18, PG 345

FIGURE 5

similar to the Tongue of the Ocean in the Bahamas today. Hull states that this area of non-deposition separated two distinct sedimentary environments: terriginous to the west and carbonate banks to the east and south. Regardless of mode of origin, all workers seemingly agree that the maximum facies change occurs in this approximate area.

POSSIBLE CORRELATIONS

The writers hesitate to make any positive statements concerning correlation at the present time. Further work is urgently needed, and by the time this report is distributed, will be underway. However, certain cautious speculations relative to gross regional interpretations are offered in Figures 6, 7, and 8.

Modifications after Toulmin (1955) are presented in Figures 6 and 7. Figure 6 shows the relatively high area south of the Florida Panhandle as a simple extension of the Ocala Uplift. If such an inference is correct, then it renders to the Uplift a gross asymmetrical configuration with a long and relatively flat western flank.

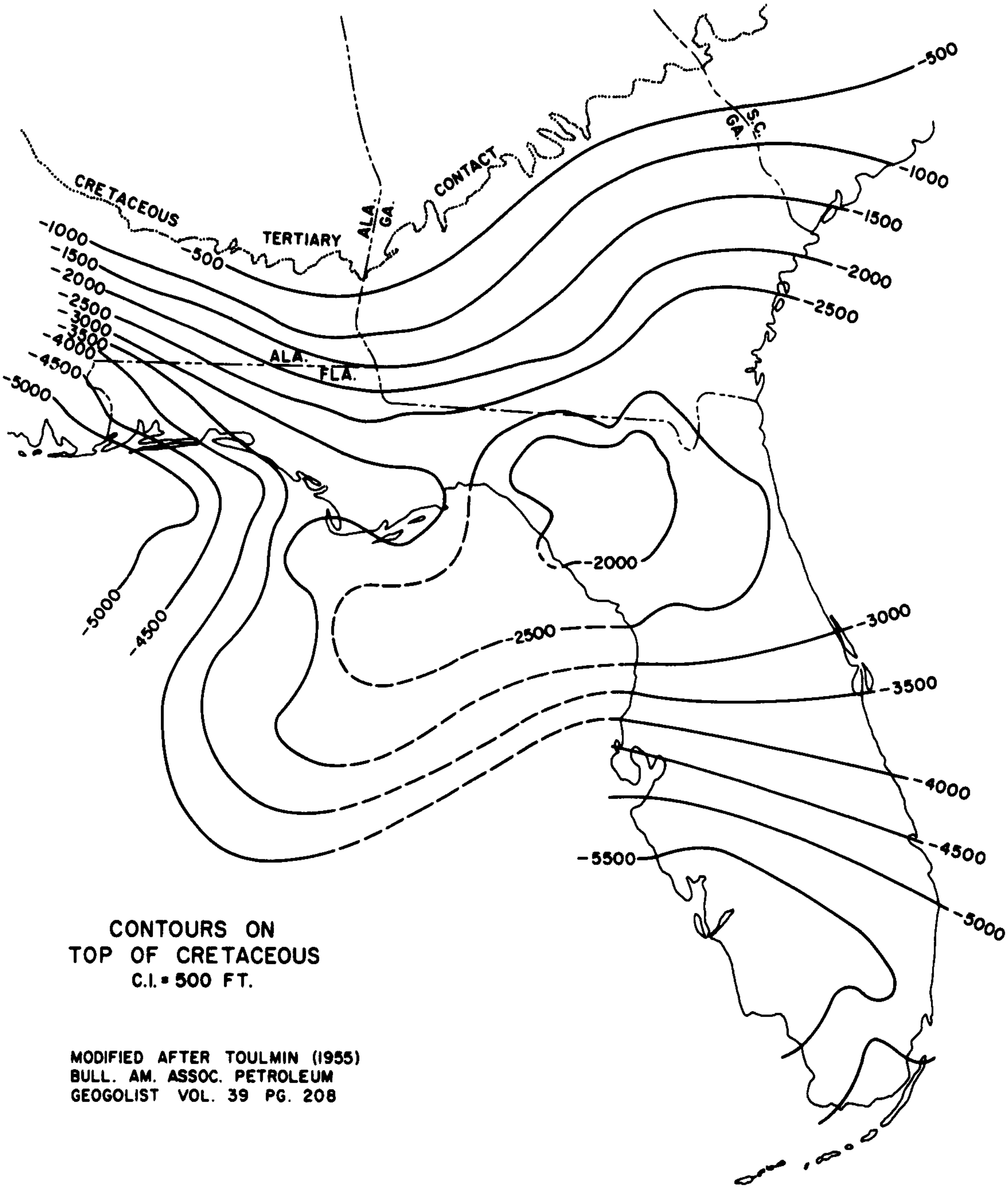
Figure 7 presents an opposing view, with the high area shown as a local feature, although possibly genetically related to the Ocala Uplift. Puri and Banks (1959) wrote of the strong development of the Ocala along the western shore of the Peninsula, and stated that it passed westwardly into a series of unnamed noses and basins culminating with the Chattahoochee Arch. With this in mind, it may be suggested that this high is related to the Ocala but is separated from the major structure by a number of highs and lows. Obviously, the answer lies in the intervening area.

Figure 8 is a modification after Jordan (1954) depicting the relationship of the 16,400 ft/sec layer as previously discussed to the regional structural aspect of the Florida Peninsula. The trough-like feature is clearly deliniated, as is the high area south of the trough. As mentioned above, although less developed and most certainly lacking in present control, this feature is strikingly similar to that shown between the Gulf Coast Geosyncline and the Sigsbee Scarp south of Texas (Antoine and Ewing, 1963). Further knowledge of the exact extent of this rise would be of great value to the interpretative history of the Gulf of Mexico Basin.

FUTURE WORK

The work to date has indicated that there are three separate, but interrelated structural features worthy of further investigation in this area:

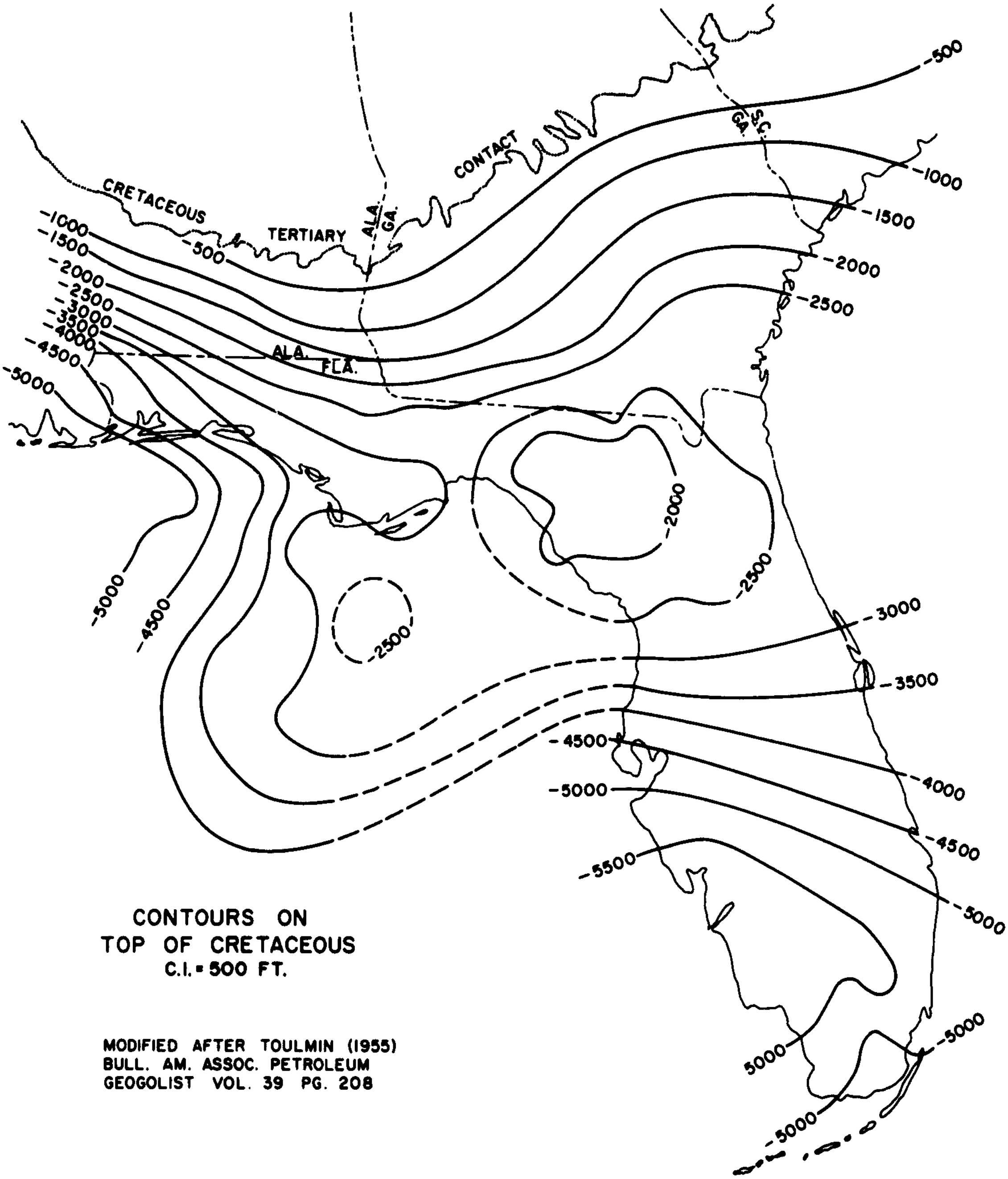
1) The relationship of the trough to the Gulf Coast Geosyncline.



CONTOURS ON
TOP OF CRETACEOUS
C.I. = 500 FT.

MODIFIED AFTER TOULMIN (1955)
BULL. AM. ASSOC. PETROLEUM
GEOGOLIST VOL. 39 PG. 208

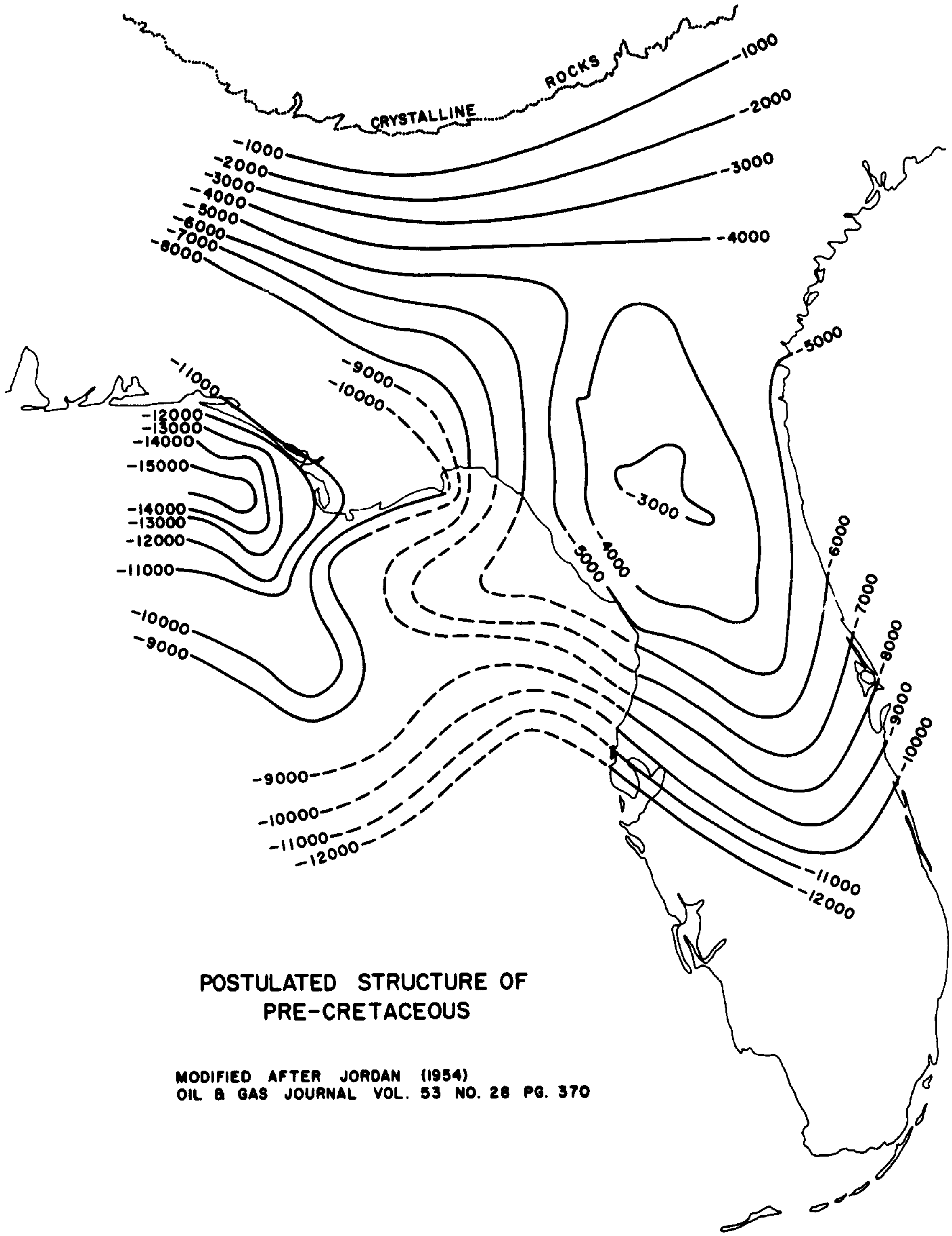
FIGURE 6



CONTOURS ON
TOP OF CRETACEOUS
C.I. = 500 FT.

MODIFIED AFTER TOULMIN (1955)
BULL. AM. ASSOC. PETROLEUM
GEOGOLIST VOL. 39 PG. 208

FIGURE 7



POSTULATED STRUCTURE OF
PRE-CRETACEOUS

MODIFIED AFTER JORDAN (1954)
OIL & GAS JOURNAL VOL. 53 NO. 28 PG. 370

FIGURE 8

2) The nature of the intervening area between the trough and the Ocala Uplift.

3) The extent of the rise southward of the trough.

For logistical reasons, the first of these to be studied will be the area between the trough and the Ocala Uplift. Other areas to be studied by future surveys are shown on Figure 9.

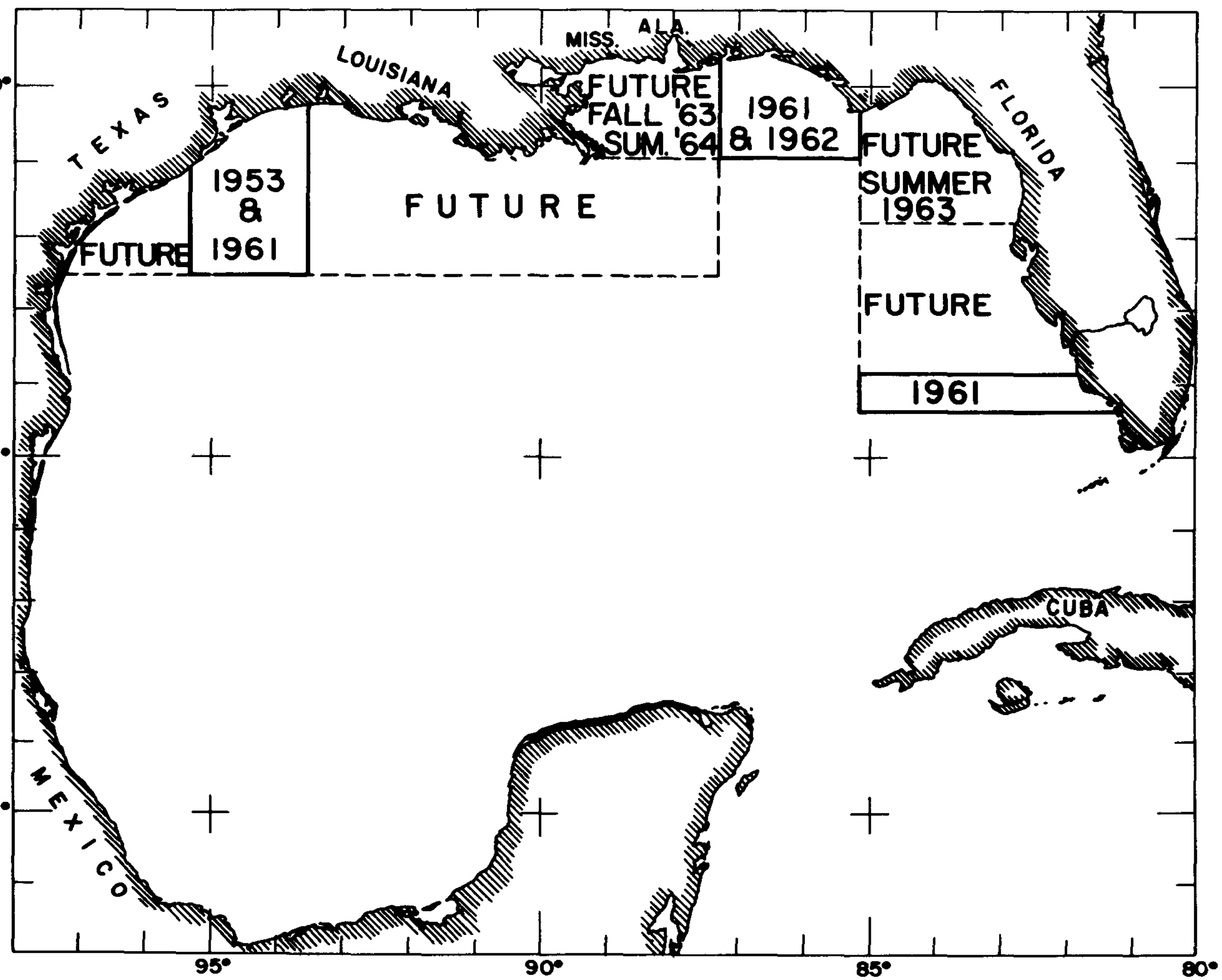

TEXAS
LOUISIANA
MISS.
ALA.
FLORIDA
MEXICO
CUBA
FUTURE
1953 & 1961
FUTURE
FUTURE FALL '63 SUM. '64
1961 & 1962
FUTURE SUMMER 1963
FUTURE
1961
30°
25°
20°
95°
90°
85°
80°

FIGURE 9

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